BRIEFER ARTICLES

DEPRESSED SEGMENTS OF OAK STEMS

(WITH FOUR FIGURES)

In a recent paper, Miss LANGDON[1] questions certain statements of the writer[2] in regard to the deeply depressed or sunken segments which occur commonly in stems of *Quercus*. She states (p. 321):

> From observations of transverse sections of twigs from *Quercus alba*, *Q. bicolor*, and *Q. macrocarpa* I find that there is evidence of retardation in growth of the tissues in the immediate vicinity of the wide rays, especially noticeable in the marked dipping in of the annual rings where they cross the large rays. However, aside from a few extreme cases, this checking influence of the wide foliar rays does not explain the 5 conspicuous depressions so characteristic of the wood of *Quercus*.

In discussing the topographical features of the stem of the oak, it is essential to distinguish between two different factors which have modifying effects upon the outline of the secondary xylem. I refer to the arrangement of the primary elements and the development of multiseriate rays. The effects of these two factors, or complexes of factors, may be studied most satisfactorily in plants where they occur independently. For example, in *Castanea dentata* and *Populus balsamifera*, which normally have only uniseriate rays, the primary elements have the stellate arrangement that is characteristic of *Quercus*. In the internodes of normal stems of these plants, the first formed secondary elements form a layer of undulating or stellate outline, but at the end of two or three growing seasons, frequently earlier, the outer periphery of the secondary xylem tends to be circular (fig. 1). In other words, the early lobed or stellate form of the cambium soon becomes evanescent, and its effects upon the shape of the stele are quite transient.

The modifying influences of the second set of factors, acting independently of the first, may be seen quite clearly in the stems of certain

[1] LANGDON, LADEMA M., The ray system of *Quercus alba*. BOT. GAZ. 65: 313–323. 1918.

[2] BAILEY, I. W., The relation of the leaf trace to the formation of compound rays in the lower dicotyledons. Ann. Botany 25: 225–241. 1911.

species of *Amphilophium*. Fig. 2 illustrates a cross-section of the stem of one of these plants. There are 4 pairs of approximated multiseriate rays in the fourth growth layer. The narrow segments of xylem between these wide rays are deeply depressed below the general outline of the stem. They obviously are not correlated with a lobed or stellate arrangement of the primary elements, but are due to differences in the number of xylem elements formed by different arcs of the cambium during the fourth growing season.

That the deeply depressed segments which occur commonly in oak stems, having 2–10 or more growth layers, are correlated with the presence of pairs of approximated multiseriate rays rather than the

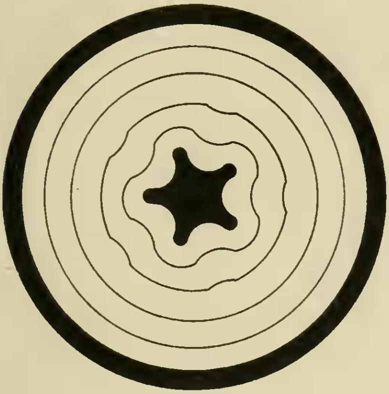

Fig. 1

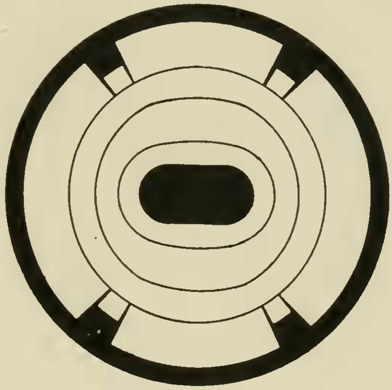

Fig. 2

stellate arrangement of the primary elements, is indicated not only by a comparative study of the stems of various arborescent dicotyledons, but also by numerous facts in the anatomy of the genus *Quercus*. From different species of oaks and from plants grown under different environmental or experimental conditions, it is possible to secure a series of stems showing various stages in the disintegration and disappearance of multiseriate rays.[3] The segments are most deeply depressed in specimens in which the pairs of multiseriate rays are most conspicuously developed (fig. 3). On the other hand, where the pairs of wide rays or their vestiges ("aggregate rays," etc.) are entirely absent, the stellate form of the early cambium, which may be conspicuous during the first growing season or two, quickly becomes circular, as in *Castanea* and *Populus*. Where there

[3] Bailey, I. W., and Sinnott, E. W., Anatomical evidences of reduction in certain of the Amentiferae. Bot. Gaz. **58**:36–60. 1914.

is a marked retardation in the development of the pairs of rays the appearance of the deeply depressed segments is coincident with that of the rays (fig. 4). Particularly significant are those stems in which one ray of a pair fails to develop. Under these circumstances, the narrow segment of xylem tends to be unsymmetrically depressed (fig. 4). Furthermore, the fact that depressed segments may occur between pairs of rays, which are opposite the projecting lobes of the pith (fig. 3), and between approximated "secondary" rays, suggests that the stellate outline of the early cambium is not an indispensible factor in the production of the sunken wedges of xylem in oak stems.

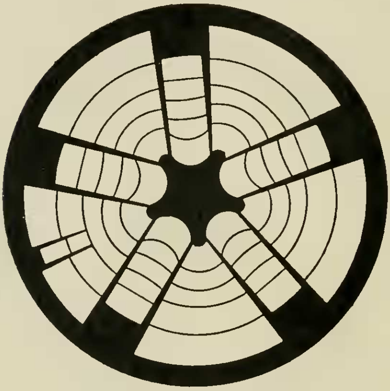

Fig. 3

Fig. 4

Miss Langdon offers a physiological explanation for the stellate form of the stele in young twigs (p. 321):

Since the principal function of the xylem is the conduction of water from the soil to the outer parts of the plant, it is obvious that the maximum upward movement of solutions in the stem would be through the tracheidal tissues and vessels in direct line with the leaf traces. This would cause an acceleration in growth and the consequent outward projection of those five regions of the woody cylinder associated with leaf traces, while the neighboring conducting tissues, namely, the so-called depressions from which the main conducting streams had been diverted to the petioles of the leaves, would fail to maintain their normal rate of growth.

It is to be emphasized, in this connection, that the projecting wedges of the first annual rings of *Castanea*, *Populus*, and *Quercus*, when devoid of wide rays, are not due to an acceleration of growth. This can readily be determined by measuring the depth of the convex and concave arcs of xylem in one or two year old stems. The average depth of the latter almost always equals and usually exceeds that of the former (fig. 1), indicating conclusively that there is no growth acceleration in the convex arcs of the cambium which form the projecting wedges. As has been indicated by the writer, the undulating outline of the first formed secondary xylem is due to the stellate arrangement of the primary elements, and consequently the stellate outline of the first formed cambium. However, this originally lobed cambium rapidly takes on a circular outline, owing to the slower growth of its convex projecting arcs, except in stems which have a hereditary tendency for the formation of pairs of approximated multiseriate rays.—I. W. BAILEY, *Bussey Institution, Jamaica Plain, Mass.*

IMPORTANCE OF EPIDERMAL COVERINGS[1]

(WITH TWO FIGURES)

In making tests of the relative resistance of some herbaceous plants to freezing, it was observed that inoculation from ice formed on the leaf surface was a factor of great importance in determining the temperature at which ice formation occurred in the leaf tissue. In testing cabbages it was observed that the greatest undercooling of the tissue below its freezing point occurred in those plants which had the greatest amount of "bloom" on the leaf surface. Plants well covered by wax could be maintained for hours at a temperature 5°C. below their freezing point without the formation of ice in the tissues. Similar conditions were found to occur in the common *Cineraria* and other such plants which are densely covered with a mat of epidermal hairs. This condition suggested that inoculation of the undercooled leaf tissue by ice formed on the leaf surface was an important factor in frost resistance. The object of this study was to determine the amount of undercooling which can occur in such tissues, and the importance of the epidermal coverings in preventing surface inoculation of the undercooled tissues.

The thermoelectric method was used to measure temperatures, since this method allows one to determine the temperature inside rather thin leaves. A copper-constantan couple of no. 40 B. and S. gauge which had a thermal coefficient of 3.33 millivolts per degree Centigrade was used. Using such a couple the delicacy of the potentiometer arrangement determines the accuracy of the temperature measurement. Although with the arrangement used much smaller changes could be

[1] Published by permission of the Secretary of Agriculture.